Tb^{3+} Doped Germanate-Oxyfluoride Glass and Glass-Ceramics

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Abstract

The purpose of this experiment is to characterize the optical properties of Terbium-doped Germanate Oxyfluoride glasses and transparent glass-ceramics (TGCs), by way of measuring its absorption and photoluminescence spectra. Terbium-doped Germanate Oxyfluoride glasses were prepared in a bulk form. These as-prepared glass samples were tested and studied for their distinct emission and absorption properties. Through the appropriate heat treatment of the as-prepared glass samples, transparent glass-ceramics were formed. The time and temperature conditions of the heat treatment were determined by values gathered after a Differential Scanning Calorimetry (DSC) conducted in a previous experiment. This change in phase is characterized by the formation of Tb^{3+}: $Pb(Cd)F_2$ nanocrystals within the glass matrix, which can be verified through x-ray diffraction (XRD). The resulting product usually has improved properties compared to the original glass material. The emission properties were tested using the 488nm Argon Laser and the 325nm He-Cd laser, and the absorption properties were recorded using a Cary 500 scan Spectrophotometer. These test were used to characterize Terbium doped glasses and glass-ceramics. Previous studies would lead to assume that there would be a general increase in emission intensity upon the transition from a glass to a glass-ceramic material, which is generally true but these results would seem to indicate that this is not true in every case. In general, an increase in Terbium concentration resulted in an increase in the luminescence intensity.
Keywords: glass, glass-ceramic, rare earth elements, luminescence

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Fabrication of Gallium Telluride Schottky Diodes with Tin and Gold Contacts

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Abstract

This is a report on an effective fabrication technique for creating tin Schottky contacts on undoped GaTe samples (99.999% purity) using a sputtering machine and testing with a Deep Level Transient Spectroscopy. For the ohmic contact on the back, gold was used, typically covering an area of approximately 3mm diameter. For the Schottky contact, tin was used, no more than 1mm in diameter, sputtered for ten minutes to create a thick, easily-visible contact. Silver wire was used to bridge the contacts with the testing frame, connected using a silver conductive paint to the GaTe and soldered to copper plates, so the tungsten probes of the DLTS could be connected to the plates without damaging and inducing stress within the fragile crystal. In this manner, a Schottky diode was successfully created, the process repeated several times.

Keywords: Schottky diode, GaTe, Fabrication

Formation and testing of Schottky diodes on gallium telluride by sputtering

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Abstract

In this paper we are reporting on the process by which we formed Schottky contacts on GaTe crystals by sputtering. GaTe crystals, grown using the Bridgeman method, were cleaved into small platelets for preparation, sputtering, and testing. Scotch Matte Finish Magic™ Tape was used to remove the rougher top surface of the layered GaTe crystals. Using an argon plasma sputtering machine, gold and tin contacts were sputtered onto opposite sides of the crystals immediately after the respective surface was stripped using the tape. The Au contacts were done first and were 3 mm in diameter. The Sn contacts sputtered secondly and were 1 mm in diameter. There is one Au and one Sn contact per crystal and one contact per side. Current-voltage, Capacitance-voltage, and DLTS (deep level transient spectroscopy) measurements were carried out on the samples to identify any Schottky diodes and analyze their characteristics. The fully automated LABVIEW controlled DLTS system was designed by SEMETROL. Samples with testable Schottky contacts were mounted to an appuratus for further testing. Four Schottky Diodes were produced using Au-GaTe-Sn. The difference between the forward and reverse current ranged from 2 orders of magnitude to .5 orders of magnitude.

Keywords: semiconductor, Schottky diode, sputter

The Growth of Graphene on Semiconductor Materials

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Abstract

In this research, two different fabrication conditions were studied in order to find new methods of manufacturing graphene and to gain an understanding of the graphene-substrate interface. The samples consist of a silicon carbide wafer and silicon wafers with a thin layer of carbon sputtered upon them. These samples were annealed at different temperatures and under various etching conditions in order to find the optimal environment needed to produce graphene sheets of high quality. An atomic force

microscope was used to study the surface morphology of the samples, while their surface chemical composition was examined by the use of x-ray photoelectron spectroscopy.Key

Keywords: Graphene, SiC, interface

PbTe Thin Films for Thermoelectric Devices

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Abstract

As the world's energy consumption continues to increase, there is a growing emphasis on the need for renewable energy sources. One source of renewable energy which has the potential to have a transformative impact is thermoelectric energy. Areas of thermoelectric research include waste heat recovery through the conversion of a heat differential to an electric current, via the Seebeck effect, as well as increased photovoltaic device efficiency through phonon blocking. In order to evaluate the efficiency of thermoelectric materials, the primary figure of merit used is the Seebeck coefficient, which is the ratio of the electrical conductivity over the thermal conductivity. PbTe, which combines good electrical conductivity with poor thermal conductivity in bulk, is a likely candidate for a good thermoelectric material on the nanoscale. This research focuses on the thin-film characteristics of PbTe fabricated using a pulsed electron-beam deposition (PED) system. The PED system was chosen as the method for deposition due to its relatively inexpensive operation and ease of use. By varying the target-to-substrate distance and holding the other parameters on the PED system constant, the effects of target-to-substrate distance upon PbTe thin films are analyzed. The characteristics of PbTe that have been examined include deposition rate, stoichiometry, and optical absorption, as well as correlations between these characteristics. By systematically characterizing PbTe across the deposition area, an improved understanding of the material is gained, including how it will behave in composite-layered form with other materials. One such composite material that holds great promise for a thermoelectrically efficient device is PbTe layered with CdTe. This future device will consist of layers of PbTe as a matrix along with relatively thin layers of CdTe as the embedded material.

Keywords: PbTe, Thermoelectric, Energy

CdTe Nanomaterials and their Effects on Thermoelectrics

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Abstract

CdTe has been an interesting prospect for studies in photovoltaics due to its unique properties and is promising for use as a nanomaterial in photo detection. Some of the properties of interest are the 1.5eV band gap, low thermal noise and large absorption coefficient. The purpose of this research is to broaden the applications of CdTe with a focus on thermoelectric devices by studying the thermal and electrical properties of CdTe nanostructures and thin films. CdTe nanolayers will be developed using Pulsed Electron-beam Deposition (PED). This allows controlled deposition of the material based on optimizing parameters including backing gas pressure, beam energy, and target to substrate distance. By changing the different parameters we can analyze the effects these changes have on the deposition of a specific material. The properties of these samples, including deposition rate, stoichiometry, surface morphology, optical transmittance, charge transport and phonon transport, will then be evaluated to establish their impact on the thermoelectric effect.
Keywords: CdTe, thermoelectric effect, PED

Quasi- Quantum Mechanics Approach

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Abstract

Momentum and energy operators in conventional quantum mechanics are defined as $\mathbf{p} = h\mathbf{k} \rightarrow -i\hbar\nabla$, $E = h\upsilon \rightarrow i\hbar\partial/\partial t$. They are then placed into an equation where the Hamiltonian equals the energy. These operators then operate on a wave function (Ψ) so that the order of operation becomes important and commutators are necessary[1]. This paper investigates a new and simpler approach to finding the energy eigenvalues of hydrogen atom. In the quasi-classical approach to quantum wave mechanics as developed by Dr. W.E. Collins, operators representing **P** and E, are represented as $\mathbf{P}=-i\hbar\nabla\Psi$ and $E_s=-i\hbar\nabla\Psi$ where E_s is the total energy minus the mass energy and **P** is the momentum. Also, all the energy terms will be represented as the energy terms operating on Ψ. In the quasi-quantum mechanical approach, commutators are not necessary since the differential operators operate only on the wave function (Ψ). With this new approach one obtains the same energy eigenvalues (up to fine structure) for the hydrogen atom as with the Dirac's relativistic approach.

Interface Observations of Silver and P3HT Using Fluorescence

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Abstract

This research observes the interface between silver (Ag) and P3HT (Poly 3-hexylthiophene) using a fluorescence spectrophotometer and the fluorescence probe, Pyrene. The spectra of these samples at room temperature and annealed at 60°C are compared. A thin film of Ag was sputtered onto a glass substrate. Pyrene and P3HT solutions in Toluene was spin-coated on top the silver. The fluorescence peak of Pyrene was found to be quenched after annealing.

Characterization of Gallium Telluride crystals as a Schottky Diode

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Abstract

A Schottky diode is a metal-semiconductor junction favored for its fast switching times and low forward voltage drop[i]. GaTe in particular is expected to perform well in gamma ray and x-ray detectors. However, GaTe has proved difficult to obtain successful characterization results. Using the DLTS (Deep Level Transient Spectroscopy) apparatus that Fisk University has supplied, the characterization research group plans to obtain accurate, repeatable data so future research groups have a foundation they can work.

The use of Fluorescence Spectroscopy to Characterize the Structural Dynamics of P3HT and Silver (Ag) Interactions for Solar Cells

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Abstract

The objective of this project is to use molecular fluorescence spectroscopy to characterize the dynamics of the interactions between P3HT (organic polymer) and Silver (Ag), as used in photovoltaic cells, in an effort to optimize their properties to create more efficient solar cells. The fluorescent probe, pyrene, was placed at the junction of P3HT on Ag, and its fluorescence obtained after excitation at various wavelengths within the ultraviolet and visible range. The experiment entailed obtaining the fluorescence spectra of pyrene/Ag, P3HT/Ag and P3HT/pyrene/Ag. Pyrene and P3HT were tested in various solvents. The fluorescent spectra data were collected and analyzed. Following this, it was determined that warm ethanol was the best solvent to be used for pyrene, (although it is a poor solvent for pyrene), and toluene for P3HT, because of the high intensity of the peak produced as a result of the combination. The P3Ht/pyrene/Ag fluorescence showed that pyrene's microenvironment is slightly polar, due to the electron conduction from the P3Ht environment to the Ag when excited by light. There are no chemical interactions between P3HT and Ag. However the intermolecular forces, provides an environment that allows their electron orbitals to interact, so that the excited electrons jump from the P3HT to the conductive silver.

Keywords: P3HT, fluorescence, probe